Costing our options

- The project has been working with a detector concept costed at $81M
    - OHCal, IHCal, EMCal, TPC, two-layers reused VTX
    - Determining total cost is not a simple exercise
- Berndt's charge is for a detector costing $75M
- At LO, means reducing $23M M&S by $4M
    - = $6M after contingency, escalation, overhead
    - $23M includes "untouchable" costs – e.g. magnet cryo, prototype activities, project management, infrastructure
    - M&S directly related to production $17M.

The M&S budget from 30,000 feet: FY16$, no contingency, no overhead

Project Management	$95,000
Magnet	$1,905,764
TPC	$2,172,000
VTX pixels	$146,000
EMCal	$4,563,000
HCal	$6,160,000
Calorimeter electronics	$4,404,200
DAQ/Trigger	$1,728,000
Infrastructure	$1,668,000
Installation	$311,500
total	$23,153,464

Thoughts guiding descoping discussions

- ensure that a program of compelling physics is possible
- see whether existing resources can reduce need to descope
- prefer descoping that retains as much of the physics in the proposal as possible
- prefer descoping that maintains full azimuthal coverage
- prefer reversible descoping options
- prefer descoping options with later go/no-go decision points
- prefer descoping options that provide appealing targets for non-DOE funding
- consider the effect on (current and potential) collaborators of descoping choices
- consider seriously that sPHENIX will consist of what we propose and nothing more

What is the appropriate target for buy-back?

- What design concepts have been put forward?
  - pCDR detector assumed two layers of VTX pixels + five layers of silicon strips + calorimeter stack
  - post C&S review (i.e. sPHENIX at “$82M”) assumes two layers of VTX pixels + TPC + calorimeter stack
- Doubtful that pCDR detector or “$82M” detector would deliver the full suite of proposal physics
- Evaluating whether reference design of ALICE MAPS three-layer inner barrel + TPC would address full physics program – though, clearly, does not fit in “$75M” constraint

What are we planning to have in the response?

- Reference design that we believe would address key physics in the proposal as reviewed by DOE – focused on the mid-rapidity program
- Description of options that have been considered, including some very unattractive ones
  - Evaluation of detector options, with performance figures derived via full simulations (only in some cases), partial simulations, expert input
- Very small number of “best worst case” configurations, with their capabilities and costs

TPC (detector)

1.3.4.4.1.3.2	Procure components: production	$750,000
1.3.4.4.1.3.3	Procure components: power supply	$84,000
1.3.4.4.1.3.4	Fabricate all boards: production	$220,000

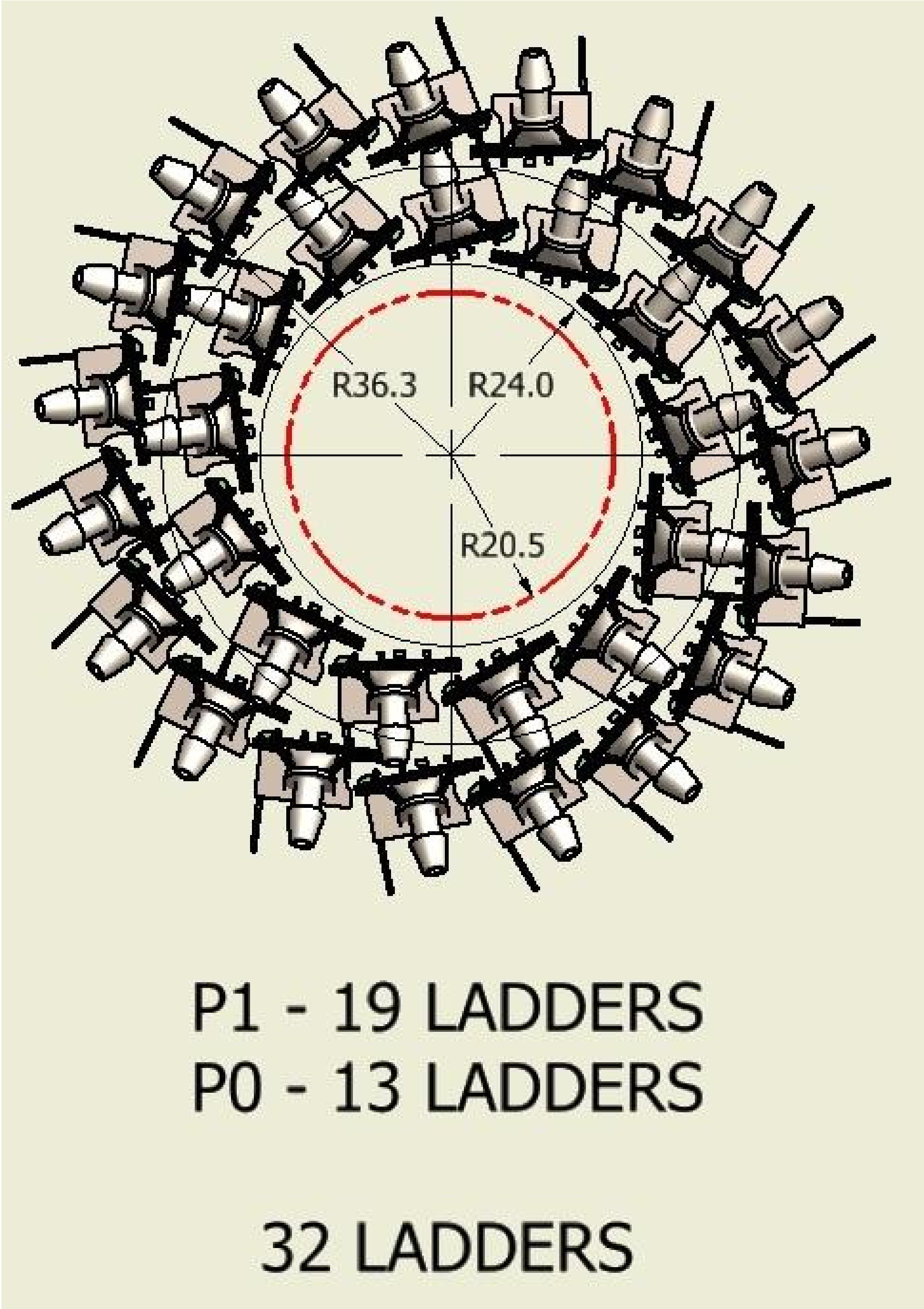
- Scheduling phone conference with Tom Hemmick, Harald Appelsheuser, others, to compile expert input on issues
- Does an sPHENIX TPC need support from non-TPC tracking to determine space charge distortion corrections sufficiently precisely? If it does, a TPC w/o this does not deliver the physics
- Are there reversible ways to descope TPC electronics? Maybe. Only instrument alternate "rings" of readout pads. Worsens dE/dx, but that's not key capability. TPC tune would likely favor minimizing ion back flow at cost of worsened σ(dE/dx)
- Don't have ability currently to simulate TPC fully (e.g., pileup)

Inner tracker considerations

- Doubtful that two VTX pixel layers + TPC provides DCA measurement
  - VTX pixel acceptance for single tracks requiring two layers: < 70% – you have to require two-of-two layers because there is no redundancy. b-tagging or D reconstruction require two tracks, so < 50% geometric acceptance.
  - Descope heavy-flavor tagged jets entirely? That would be a serious loss.
- ALICE inner barrel (three-layer MAPS pixels). Santa Fe workfest: IB cost ~$4M, very hard to fit in "$75M" charge
  - Enough tracking to support space charge distortion corrections for TPC? Need expert input
- One layer of ALICE-style MAPS?
  - Combined with one outer layer of VTX pixels – potential for some physics, locates VTX farther away from beam pipe to address (as yet unsubstantiated) connection to radiation issues
  - sPHENIX would benefit from ALICE commissioning experience of their MAPS tracker

VTX pixel stave inventory

	Ladder ID	Working Pixels (%)	Location		Ladder ID	Working Pixels (%)	Location
01	L43 (new)	94.4	BNL	21	L14 (used)	79.8	BNL
02	L47 (new)	94.4	BNL	22	L16 (used)	79.7	BNL
03	L41 (new)	94.3	RIKEN	23	L35 (used)	79.4	BNL
04	L46 (new)	94.1	RIKEN	24	L5 (used)	78.6	BNL
05	L44 (new)	94.0	RIKEN	25	L12 (used)	77.4	BNL
06	L45 (new)	93.2	RIKEN	26	L25 (used)	75.3	BNL
07	L24 (used)	93.2	BNL	27	L6 (used)	72.9	BNL
08	L39 (used)	94.9	BNL	28	L34 (used)	72.0	BNL
09	L8 (used)	90.1	BNL	29	L11 (used)	71.8	BNL
10	L17 (used)	89.3	BNL	30	L15 (used)	70.7	BNL
11	L26 (used)	87.4	BNL	31	L18 (used)	69.3	BNL
12	L19 (used)	84.7	BNL	32	L10 (used)	66.1	BNL
13	L36 (used)	84.6	BNL	33	L32 (used)	61.7	BNL
14	L33 (used)	83.4	BNL	34	L27 (used)	44.7	BNL
15	L23 (used)	83.4	BNL	35	L20 (used)	32.6	BNL
16	L31 (used)	83.3	BNL	36	L30 (used)	0.0[a]	BNL
17	L22 (used)	82.9	BNL				
18	L9 (used)	80.8	BNL				
19	L21 (used)	80.4	BNL				
20	L13 (used)	80.4	BNL				

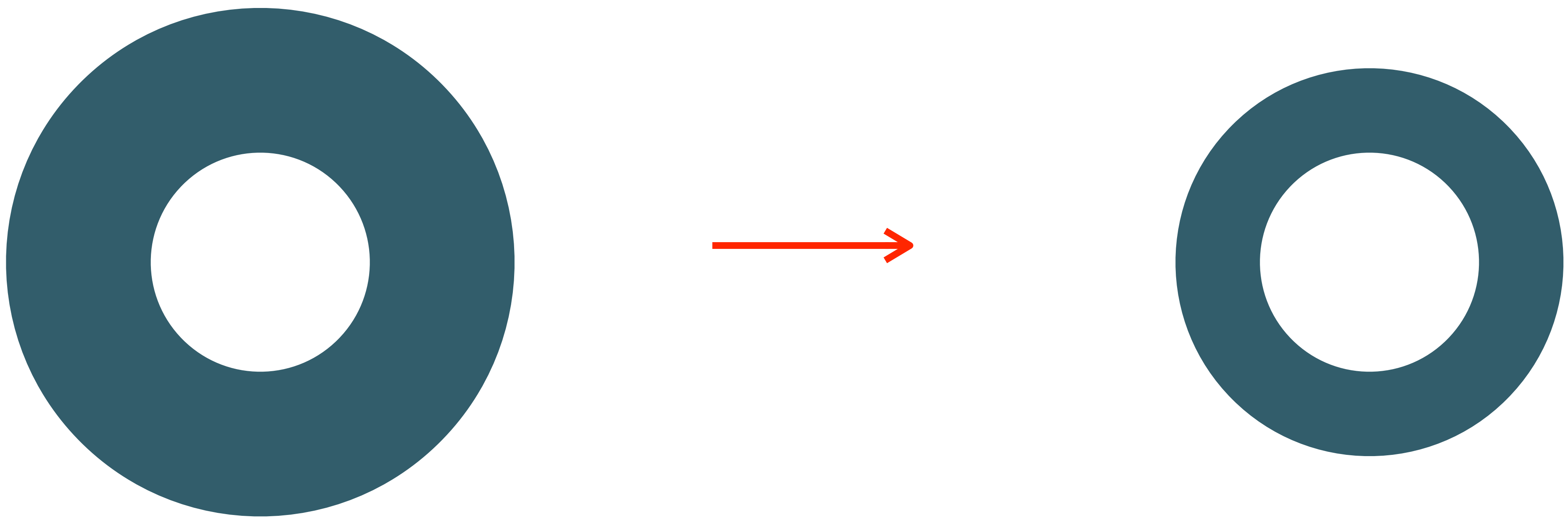


VTX pixel timing jumps

- Discovered recently – i.e., new information since time of pCDR and C&S review
- Timing jump issue appears to be correctable in the recorded data, but root cause has not yet been diagnosed
- Correcting data requires correlation with another detector. In Au+Au can be BBC. In p+p and p+A, that correlation is quite weak, instead possibly rely on clock triggers
- If effect is radiation dose related, would be a concern in sPHENIX

Outer HCal

1.5.3.3.1.4	Procure absorber	$3,830,000.00
1.5.3.3.1.8	Procure scintillator tiles	$1,199,000.00



- steel needs to extend past end of solenoid (mechanical support, flux return)
- steel needs to be thick enough to handle flux return: conceivably reduce 86 cm to ~45 cm; save ~$2M of machined steel?
  - increased energy leakage leads to low-side tail on calorimeter response – effects on triggering, FFs, jet energy determination – studies needed to see how severe and whether can be ameliorated
- **but**, steel is long lead time item on critical path, so descope presents an immediate go/no-go decision

Inner HCal

1.5.2.3.1.4	Procure absorber	$415,000.00
1.5.2.3.1.8	Procure scintillator tiles	$155,000.00

- similar long-lead time procurement leading to near-term go/no-go decision as with outer HCal
- accounts for 14% of $4M target
- thinning doesn’t save much in material cost
- few read-out channels, limited opportunity to reduce costs there
- still need to support EMCal, so would have to add back in a cost for that structure

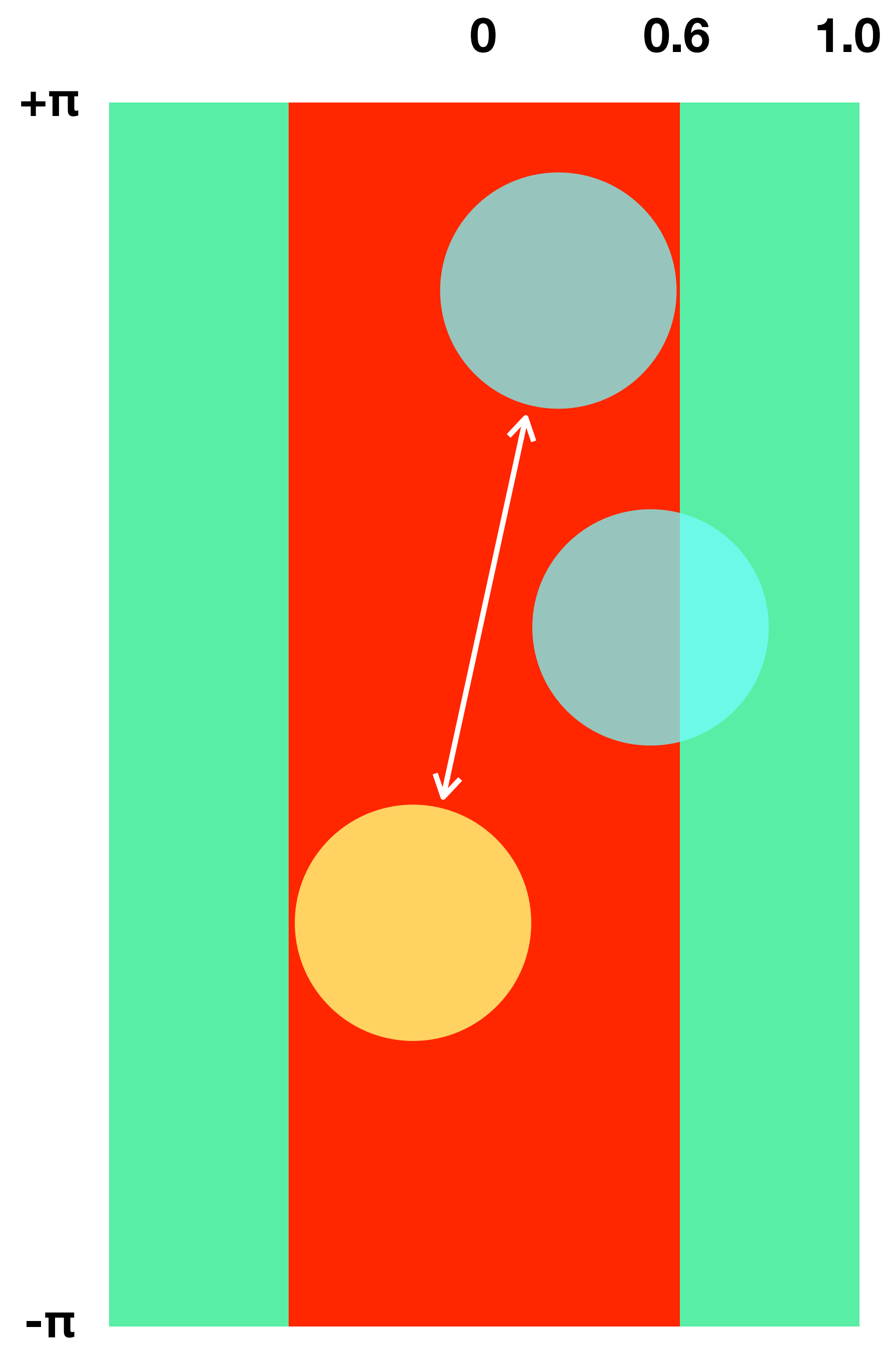
1.4.4.1.8	Fabricate modules	$3,680,000
1.6.2.2.11	Order production EMCal sensors	$920,000
1.6.3.3.2	Procure components: production	$1,265,000
1.6.3.3.3	Fabricate all boards: production	$134,000
1.6.4.3.2	Procure components for digitizer system: production	$1,100,000
1.6.4.3.3	Fabricate Boards for digitizer system: production	$425,000

EMCal

- “gang” together 2×2 towers saves about $2.4M
    - possibly OK for direct photons – γ dominate over π yields at high p_T; will degrade isolation cuts, affecting Au+Au
    - will degrade e/π separation and worsen Υ statistics – bigger effect in Au+Au; checking severity of effect though simulations
    - readily bought back capability
    - later go/no-go decision compared to some other descoping options

EMCal

- option: only build towers out to |η| ~ 0.6 (half the towers)
  - more limited containment for jets and dijets in uniform part of acceptance – checking numbers
  - LHC experience– dealing with jets spanning detector boundaries subject to large systematic effects



DAQ/Trigger

1.7.2.3.2	Board production (DCMs)	$250,000.00
1.7.2.3.6	Procure SEBs	$100,000.00
1.7.2.3.7	Procure ATPs	$200,000.00
1.7.2.3.9	Procure new Bufferboxes	$150,000.00
1.7.2.3.11	Procuring the main switch	$250,000.00
1.7.3.2.3.2	Procure the components for the MB Detector	$500,000.00

- Investigate using/copying STAR's new SiPM-based trigger detector instead of building one: save/reduce $0.5M
- Reduce data collection module (DCM) purchase through multiplexing. Direct trade-off against min. bias data.
- Reduce DAQ computing refresh (SEBs, ATPs, buffer boxes) – maybe get RACF cast-offs?
- Descope network switch refresh – ramifications for maximum event rate? Does STAR have equipment that could be used?

An example

- 2×2 ganging of 2D projective EMCal towers (save \$2.5M)
- descope elements of DAQ/Trigger (use STAR's EPD?) (save \$1M)
- sparser TPC pad readout (save \$0.5M)
- **total savings:** ~\$4M
- **pros**: reversible, retains full η coverage, maintains role for non-BNL institutions in building detectors (e.g., EMCal, inner HCal)
- **cons**: no DCA capability ➛ no HF-jet tagging; no tracking support for TPC ➛ worsened momentum resolution at high p_T ➛ worsened high-z FF; worsened eID ➛ reduced Υ statistics and compromised photon isolation capability

Another example

- $2{\times}2$ ganging of 2D projective EMCal towers (save $2.5M)
- thin outer HCal to flux return minimum (save $2M)
- descope elements of DAQ/Trigger (use STAR's EPD?) (save $1M)
- sparser TPC pad readout (save $0.5M)
- **total savings:** $6M
- **new costs:** add single layer MAPS inner barrel ($1-2M) + reconfigure VTX into single layer
- **pros**: reversible, maintains role for non-BNL institutions in building detectors (i.e., EMCal, inner HCal), sends positive message to potential MAPS capable institutions and keeps sPHENIX in MAPS production pipeline
- **cons**: unclear whether adequate tracking support for TPC; worsened eID ➛ reduced Υ statistics and compromised photon isolation capability; limited uniform acceptance ➛ reduced jet and dijet acceptance, compromised ability to study jet R dependence

Discussion

- need to settle on small number of options to investigate
    - TGs are focusing on good, specific questions related to physics
- involve Project in costing these options in an official way